WHAT IS CLAIMED IS:

1. A process of preparing a chemically bonded ceramic comprising:

(a) as a first step, preparing a slurry of solvent and hydroxide ceramic;

(b) as a second step, heat treating the hydroxide ceramic slurry at a temperature of between about 100 to 800°C to produce a dehydrated oxide ceramic;

(c) as a third step, phosphating the dehydrated oxide ceramic with a phosphating agent to seal pores in the surface of the dehydrated oxide ceramic and produce a phosphated oxide ceramic; and

(d) as a fourth step, heat treating the phosphated oxide ceramic at a temperature between about 200°C and about 1200°C.

2. A process as claimed in claim 1, wherein the solvent is water, with the pH of the slurry being between about 2 to 6, methyl alcohol, ethyl alcohol or isopropyl alcohol.

3. A process as claimed in claim 1 wherein the slurry in the first step (a) is a mixture of calcined alumina, hydroxide derived alumina and water which is impregnated according to step (c) with a mixture of metal phosphate and phosphoric acid to form complex amorphous or crystalline phosphates during heat treatment.

4. A process as claimed in claim 1 wherein the pores in the surface of the chemically bonded oxide ceramic are sealed by utilizing a process selected from one or more of the group consisting of hydroxide impregnation, hydroxide electrophoretic deposition, aluminum phosphate impregnation, and phosphorus acid impregnation.

5. A process as claimed in claim 1 wherein the oxide ceramic can be one or more of SiO_2, Al_2O_3, ZrO_2, TiO_2, BeO, SrO, BaO, CoO, NiO, ZnO, PbO, CaO, MgO, CeO_2, Cr_2O_3, Fe_2O_3, Y_2O_3, Sc_2O_3, HfO_2 or La_2O_3.

6. A process as claimed in claim 1 wherein the phosphating agent is a metal phosphate, phosphoric acid, phosphorous acid, or mixtures thereof

one or more of Al, Zr, Ti, Mg, Cu, Fe, Ca, Sr, Hf or Cr, Ba, Mo, Ni, Zn, Pb or Sn.

8. A process as claimed in claim 5 wherein a calcined ceramic filler comprised of powders or fibers of oxides, carbides, nitrides, borides, sulphides, fluorides or mixtures thereof, is included in the slurry of step (a).

9. A process as claimed in claim 3 wherein the hydroxide derived alumina is partially amorphous or crystalline alumina produced through thermal decomposition of boehmite-type hydrated alumina AlOOH, or equivalently aluminum oxide monohydrate $Al_2O_3 \cdot H_2O$.

10. A process as claimed in claim 1 wherein in step (a) a substrate is immersed in the slurry to coat the substrate, the substrate is withdrawn from the slurry and the coating on the substrate is dried at a temperature of 50 to 400°C, before proceeding with step (b).

11. A process as claimed in claim 10 wherein pores in the surface of the ceramic coating on the substrate are sealed by treating the ceramic coating with phosphoric acid for about 1 to 20 minutes, polymerizing the phosphoric acid treated ceramic coating at a temperature of about 100 to 300°C for 20 to 50 minutes; and subsequently further treating the coating at a temperature of 500 to 800°C for about 10 to 50 minutes.

12. A process as claimed in claim 10 wherein in step (a) the ceramic slurry is produced by mixing a hydroxide solution with a metal oxide ceramic powder; the ceramic hydroxide slurry is applied to the substrate to produce a ceramic coated substrate, the ceramic coated substrate is heated to a temperature of up to about 1000°C to produce a ceramic metal oxide film on the substrate; and surface pores of the ceramic coating are sealed with a phosphorus containing ceramic sealant.

13. A process as claimed in claim 10 wherein the surface sealing process (d) is selected from the group of processes consisting of hydroxide impregnation, hydroxide electrophoretic deposition, aluminum phosphate impregnation and phosphorus acid impregnation.

aluminum hydroxide derived oxide coated substrate

15. A process as claimed in claim 14 wherein the aluminum hydroxide derived oxide coated substrate is treated with phosphoric acid and the phosphoric acid is reacted with the ceramic coating at a temperature of at least 200°C for at least 2 min.